

MEMORANDUM

To: The File
From: Glenn Farber, Economics, Methods, and Risk Analysis Division
Date: 13 February 2002
Subject: Regulatory Impacts of Proposed Exclusions of Petroleum Refinery Wastes

PURPOSE

This memo is a brief analysis of the anticipated regulatory impacts of the proposed exclusion for refinery wastes processed in gasification systems. The analysis consists of an assessment of

- waste management in the baseline scenario
- waste management in a post-regulatory scenario
- possible economic impacts of implementing the rule
- possible social benefits and costs from incremental changes.

The proposed rulemaking discusses an exclusion for refinery wastes, as well as an option for excluding additional wastes destined for gasifiers. This memo only addresses the exclusion for petroleum refining wastes (i.e., generated by facilities in SIC code 2911).

BASELINE SCENARIO

The baseline scenario describes waste generation and management as it would exist in the absence of the proposed rule. For this rulemaking, there are two universes of concern:

- Waste generation and management by petroleum refineries
- Operation of slagging gasifiers¹ in the U.S.

¹Wastes going to non-slagging gasifiers do not meet the criteria for the exclusion, since producing a slag is part of the rule definition of gasifiers. See Section VII-A-1 of the preamble.

Hazardous Waste Generation by Petroleum Refineries

The 1997 Biennial Report includes 172 refineries in SIC code 2911 that are generating a total of 131 tons of RCRA hazardous wastes². These wastes are either characteristic, or are listed under one or more hazardous waste listings. Listed hazardous wastes associated with the petroleum refining industry include:

Waste Code	Waste Description
K048	DAF float
K049	slop oil emulsion solids
K050	heat exchanger bundle cleaning sludge
K051	API separator sludge
K052	Tank bottoms (leaded)
F037	primary oil/H ₂ O separation sludge
F038	secondary oil/H ₂ O separation sludge, including DAF float
K169	crude oil storage tank sludges
K170	clarified slurry oil sludges
K171	hydrotreating catalysts
K172	hydrorefining catalysts

Excluding wastes managed in units exempt from RCRA permitting (e.g., wastewater treatment tanks), the total quantity of hazardous waste generated annually by petroleum refiners is between 5.85 and 10.1 million tons.³

²This data does not account for petroleum wastes delisted in subsequent years.

³ Data represents total generation of the waste code by facilities in SIC code 2911 in 1997. Source: Biennial Reporting System.

Refinery Wastes Currently Being Processed in Gasifiers

EPA is aware of four refineries currently processing RCRA hazardous wastes in a gasification unit.

- The Texaco refinery in El Dorado, Kansas
- The Motiva Enterprises refinery in Delaware City, Delaware.
- The Exxon refinery in Baytown, Texas.
- The BP/Amoco refinery in Mandan, North Dakota

EPA does not currently have details on the quantity of hazardous waste being processed in these gasifiers. The most we can say is that the quantity is some proportion of the 6-10 tons noted above.

The North Dakota gasifier is not a slagging gasifier, and thus does not meet the criteria for the exclusion. The other three facilities, which are processing wastes in an on-site slagging gasifier, are the only refineries that are immediately affected by this proposal. There are many other facilities expected to be affected, however; the effects of the rulemaking are discussed in the post-regulatory scenario, below.

POST-REGULATORY SCENARIO

The post-regulatory scenario describes management of refinery wastes after the assumed promulgation of this rulemaking. The post-regulatory scenario, like the baseline scenario, begins with the the effective date of the rulemaking.

Since benefits and costs derive from the change in regulations, it is helpful to examine what regulatory status is associated with various materials and entities associated with gasification of refinery wastes. The table below compares regulatory status in both the baseline and post-regulatory scenarios.

Regulatory Status of Gasifiers and Wastes

<u>Material</u>	<u>Baseline Regulatory Status</u>	<u>Post-Regulatory Status</u>
Gasifier input: Hazardous waste feedstocks	Regulated under Subtitle C, unless the synthesis gas is used as an ingredient in a product.	Not a solid waste; not regulated* CHANGE IN STATUS
Gasifier output: Waste slags	Possibly regulated wastes. ⁴	Not regulated* (unless characteristic) POSSIBLE CHANGE IN STATUS
Gasifier output: synthesis gas fuel	The syngas is not considered a waste; it is exempted from Subtitle C regulation under 40 CFR 261.38 if it meets specifications there	Not regulated
Gasifier output: other non-fuel chemical products (e.g., elemental sulfur or chlorine)	These are products and not wastes; they are generally not subject to Subtitle C regulation	Not regulated

* if it meets the conditions

The change in regulatory status is most likely to affect hazardous secondary materials used as feedstock for the gasifiers (first row in the table). This memo focuses on those secondary materials directly generated by petroleum refiners, and costs and benefits which would be attributable to this proposed rulemaking.

Estimated Industry Response to Rule

The critical issue in projecting industry response is to estimate whether refiners generating eligible wastes would shift management of those wastes from RCRA treatment and disposal into gasification.

Refiners:

For purposes of this analysis, we assume that those refiners currently feeding wastes to gasifiers will continue to do so. We assume that these and other refiners will send additional

⁴ The status of these slags in the baseline is not certain; they may be "derived-from" wastes, they may be considered ingredients for other products, and they may be Bevill exempt (if feedstocks are at least 50% coal).

wastes (from those refiners and the 168 others) to gasifiers if:

- 1) The wastes are "oily wastes" eligible for the exemption. With the possible exception of wastewaters, it appears that most refinery wastes would fall into this category.
- 2) The cost of sending wastes to gasification, including transportation, is lower than the costs of treatment and disposal of wastes at Subtitle C permitted facilities. Any refinery which generates oil-bearing RCRA wastes would have the choice of sending those wastes to RCRA treatment and disposal, or to eligible (on-site or off-site) gasification units.

We don't currently have data on the costs of gasification of wastes compared to the costs of RCRA-compliant treatment and disposal. However, it is likely that gasification presents a cost advantage to refiners over hazardous waste treatment and disposal:

- a) Gasifiers could charge refineries tipping fees to accept these materials. Since gasifiers are currently paying for feedstocks like coal, it would seem logical that they would always be able to charge tipping fees less than the costs of hazardous waste treatment and disposal.
- b) In addition, there are other private and social benefits to gasification, besides lower costs of waste management. Refiners with captive units can use gasifiers to produce useful products for their process, including power; gasifiers can improve the internal economics of refineries by lowering costs and improving operational efficiencies.⁵ Therefore, makes sense for them to gasify these materials, especially (but not only) if they have captive gasification units. Even refineries without on-site gasification units would likely find lower costs to send waste to off-site gasification than to off-site treatment and disposal facilities.

Therefore, the cost of gasification is not likely to be an obstacle, except where the costs of hazardous waste treatment, transportation, and disposal are exceptionally low. It is reasonable to project that significant volumes of secondary materials would move from

⁵ See Clint F. Penrose, et. al., "Enhancing Refinery Profitability by Gasification, Hydroprocessing, and Power Generation," October, 1999. Available at the web site of the Gasification Technologies Council, www.gasification.com.

refineries to gasification, under the right circumstances.

Gasification Operators

According to the database compiled by the Department of Energy, there are 26 facilities in the U.S. operating gasifiers, with a total of 51 separate gasification devices.⁶ An addition 12 gasifiers are due to come on line by 2005. Since gasification operators could receive tipping fees from the refineries, gasification operators would likely find refinery wastes as feedstocks to be financially preferable to alternative inputs (e.g, coal) that the gasification operator would need to pay for. We assume that gasification operators will readily accept additional wastes, as long as the wastes are suitable feedstock for the gasification process.

The full extent of wastes that are suitable feedstock is not yet clear, however. Gasification devices are expensive and somewhat sensitive machines, and engineering considerations of operation and maintenance limit the types of materials that can be used as feedstocks. Limitations may relate to the chemical constituents and the physical and chemical properties of the waste products.

The suitability of these secondary materials from refineries would therefore appear to be the most significant source of uncertainty in projecting the amount of these materials that would likely be diverted to gasifiers.

Chemical Industry

Gasification is also used to produce valuable chemical products such as hydrogen chloride and elemental sulfur. In addition, the synthesis gas can be used to produce products such as diesel fuel, methanol, and ammonia. However, most wastes used as feedstock for these processes are already excluded from RCRA regulations under 40 CFR 261.2(e)(1)(i). Therefore, we do not assume that this regulation will have any effect on the chemical industry, even if refinery wastes are used in gasification. There may be, however, a potential for some increase in the supply of these chemicals, if this regulation changes cost structures sufficiently to induce industry to build additional gasification capacity.

How much waste would be diverted to gasification?

To estimate what wastes might be gasified, we examined the current disposition of petroleum

⁶ Dakota Gasification in North Dakota has 12 gasifiers on site, but these are ineligible under our rule.

refining wastes.

- *Hazardous waste treatment and disposal:* The American Petroleum Institute reports that only about 16% of oily refinery wastes are currently going to treatment and disposal⁷. It would be logical for refiners to seek to gasify those wastes, under the assumption that tipping fees from gasifiers would be less expensive than Subtitle C treatment and disposal.
- *Coking:* Nearly ¾ of the remaining wastes are being fed to petroleum cokers, to recover valuable materials. Petroleum coke is a preferred feedstock for gasifiers⁸, which provide a means for extracting further value from the coke. Coking recovers some light ends for re-insertion into the refining process, with coke as another end product. Gasification could thus be a follow-up step after coking, or it could replace coking to some extent.
- *Other recycling / reclamation:* Refineries also use catalytic crackers and thermal desorption for additional reclamation, and use other materials for fuel. It is difficult to project to what extent these wastes (or residual products from these processes) might be diverted to gasification.

Even if we assume that refineries continue to use other processes (such as thermal desorption and catalytic cracking) to reclaim value from other materials, as much as 90% of the petroleum residuals could be shifted into gasification. This would be an estimated 6.1 - 9.1 million tons of waste annually diverted to gasification. Of that total, 16% – between 1.1 and 1.6 million tons — would have been sent for hazardous waste treatment and disposal in the baseline scenario.

Anecdotal information also suggests that gasifiers clearly have the capacity to accept that volume of wastes, and more. The total quantity of residual materials from *all* refineries in the US makes up a small proportion of the total volume of feedstock necessary for any one gasifier.

It is still difficult to project what volume of wastes might move to gasification, in the absence of information on operating standards for the gasifiers, and what wastes would meet

⁷ API, *Management of Residual Materials*, 1996: Petroleum Refining Performance, Publication 345, June, 1998; pp. 4-1 and 4-2.

⁸ SFA Pacific, Inc. for the U.S. Dept. of Energy & Gasification Technologies Council, *Gasification: Worldwide Use and Acceptance*, January 2000.

engineering criteria as acceptable feedstocks. Our estimate of regulatory impacts, therefore, is limited to an bounding estimate, using the assumption that all 6-10 million tons of petroleum refinery non-wastewaters would move to gasification. This estimate, of course, only represents the outside limit of materials which could be shifted from Subtitle C treatment and disposal, and we are requesting comment on these issue with this proposal..

ECONOMIC IMPACTS

Refineries: The proposal discusses an option limiting the exclusion to facilities in the petroleum refining industry, defined under the Census Bureaus's Standard Industrial Classification code 2911. This industry includes the production of petroleum products through distillation, fractionation, and/or cracking of crude oil and unfinished petroleum derivatives. Total 1999 employment in the sector was 63,500, and the value of products estimated at \$170 billion.

API has estimated that petroleum refineries spent a total of \$210 million in 1999 for hazardous and solid waste management. If all 6-10 million tons of non-wastewater residuals produced annually are diverted to gasifiers, refiners stand to save a large portion of that cost — less tipping fees charged by the gasifiers.

Gasifiers: Operators of gasification devices would stand to gain from this rulemaking. Since the alternative destination for these refinery residuals is hazardous waste treatment, the gasifiers should be able to receive tipping fees for accepting these materials. An exclusion for all refinery wastes would foster competition in the market for these secondary materials. Since these materials are replacing (to some extent) other feedstocks for the gasification system, tipping fees for these materials could be charged. For refiners operating an on-site gasifier, the cost of feedstocks that come from the refinery itself (e.g., petroleum coke) is the opportunity cost; namely, the other uses to which the coke could be applied. To the extent that refinery wastes supplant these other feedstocks for the gasifier, this rule reduces the cost of operating the gasifier. We have not attempted to model this market, nor determine supply and demand or prices. It is clear, however, that revenue streams from tipping fees would be bounded by current management costs — i.e., less than \$210 million annually.

Hazardous Waste Treatment and Disposal Industry: Using the upper limit bounding estimate, we could assume that all oily residuals that are currently sent for hazwaste treatment and disposal — between 1.1-1.6 million tons of waste annually — could be diverted from hazardous waste TSDFs to gasification. Our outside bound estimate suggests that is the upper limit of the loss to the hazardous waste treatment and disposal industry. These losses are largely transfers to the refineries generating the wastes, and off-site gasifiers accepting the wastes.

SOCIAL COSTS AND BENEFITS

Costs associated with this rule are expected to be minimal, including time to read the rule, residual (i.e., slag) testing and other tasks to meet the conditions. Generators who choose to take advantage of the exclusion may incur cost to meet specifications for the synthesis gas, or to meet Universal Treatment Standards the slags produced in gasification.

Losses to the hazardous waste treatment and disposal industry are expected to constitute transfers to generators and gasification owner/operators; although these may be significant impacts, they are not true economic costs. Therefore, **the direction of social benefits from this proposal can only be positive.** Uncertainties and assumptions about the quantity of waste which would be excluded do not affect our assessment of positive net benefits stemming from this rule; they only affect the *magnitude* of that net benefit.

Benefits from this rule are likely to include:

- *Cost savings in treatment and disposal costs for wastes:* The magnitude of these savings is difficult to project, but the upper bound would be the \$210 million that refineries are currently spending on waste management. Some part of those savings are transfers — revenues previously received by the hazardous waste treatment and disposal industry. The true social cost savings do not include those transfers, but only include the net cost reduction of managing these residual materials. Therefore, the savings in social costs will be less than the cost savings accruing to the generators and gasification operators.
- *Administrative cost savings:* Both generators of refinery wastes and Federal/state RCRA regulating agencies are expected to save administrative burden and costs because of this regulatory change.
- *Reduced costs of production:* Depending on how markets and prices develop, this rule could also result in reduced costs of electricity, and reduced costs for chemical intermediates that gasification systems produce.
- *Resource conservation benefits:* We project that this rule will facilitate gasifiers in substituting secondary materials (formerly disposed as wastes) for coal. To the extent that this rule induces power generators to burn synthesis gas instead of coal, there is the potential for additional resource conservation benefits.

Environmental Benefits

Environmental changes from gasification vs. hazardous waste treatment and disposal: EPA has determined that there is no significant threat to human health or the environment from refinery wastes managed under standards of RCRA Subtitle C, nor from refinery wastes recycled in a gasification device. There are generally no direct emissions to the atmosphere from a gasification system⁹. Therefore, this rulemaking is not expected to result in any direct reduction in those categories of risk.

Environmental changes from combustion of synthesis gas vs. combustion of coal: This rulemaking will provide incentives for refineries generating hazardous wastes to shift their management of those wastes into gasifiers. To the extent such a move happens, it will also change the cost structure for gasifier operations. If the cost shift is significant enough, it could induce changes in the electric power industry by causing — to some degree — a substitution of synthesis gas for coal as a fuel for producing electricity. To the extent that this proposed rulemaking would induce that substitution to take place, significant environmental benefits may occur, including:

- reduction in emission of acid rain causing pollutants;
- reduction in emission of greenhouse gases¹⁰;
- reduction in particulate matter;
- reduction in energy usage and pollution from reductions in the acquisition, transportation, and preparation of virgin materials used in electricity production, and petroleum refining.

These benefits could be significant, but will only be attributable to this proposal if the incentives provided by this rulemaking induce some degree of shift from coal to synthesis gas. Only a more complete analysis of costs, refinery operations, and energy markets will allow us to project whether such a shift is likely.

⁹ Devices that utilize incinerators to combust non-gaseous effluents from the gasification process, or raw synthesis gas cleanup systems would still be subject to appropriate regulations to control emissions from those sources.

¹⁰ Reduction in greenhouse gases and other environmental benefits from gasification will be evaluated at the Georgia-Pacific XL project. See <http://www.epa.gov/projectxl/georgia/index.htm>